Volume 26 April 1940 *Number 4*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Electric Motor Bearings

Protection by Lubrication

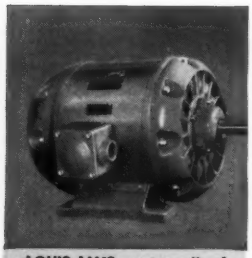
PUBLISHED BY

THE TEXAS COMPANY

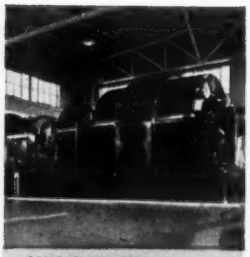
TEXACO PETROLEUM PRODUCTS

LONGER LIFE

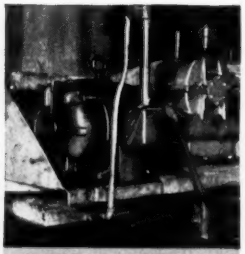
for ELECTRIC MOTORS of every make . . . every duty!



LOUIS ALLIS . . . streamlined explosion-proof unit . . . widely used in chemical plants.

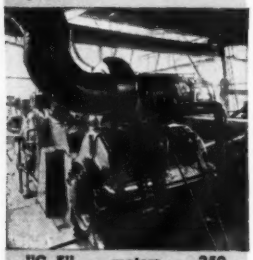


ALLIS-CHALMERS . . . synchronous 800 h.p. unit driving gas booster.



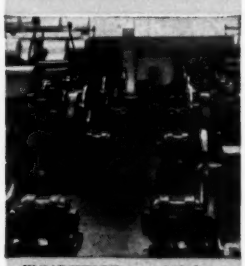
CENTURY . . . splash-proof motor operating conveyor hosed down daily.

FAIRBANKS-MORSE . . . 30 h.p. motor operating reduction gear on sand muller.



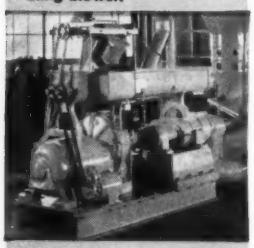
"G-E" . . . motors . . . 350 h.p. unit driving rotary oil driller . . . 5 h.p. unit operating blower.

LELAND . . . 3 h.p. explosion-proof motors handling inflammable liquid pumps.



"LINC-WELD" . . . 1½ h.p. units driving Whitin Combers in Southern textile mill.

MASTER . . . 5 h.p. units with built-in gear unit, revolving tumbler drums.



STERLING . . . 25 h.p. and 2 h.p. motors operating pellet machine and conveyor in milling plant.

WESTINGHOUSE . . . 5 h.p. motor with sealed sleeve bearings, operating forge hammer.

IN ALMOST every field where electric motors are used there is a long standing preference for Texaco's oils and greases. This is based upon proof that the electric motor lubricants recommended by Texaco, go a long way to assure long and useful life, low repair and maintenance expense.

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The Texas Company, 135 East 42nd Street, New York, N. Y.

TEXACO

TEXACO Lubricants FOR ELECTRIC MOTORS

LUBRICATION

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Electric Motor Bearings

Protection by Lubrication

ELECTRIC motor lubrication is a matter of bearing lubrication. The motor is a most versatile unit as it permits of the use of virtually any type of bearing design. Of necessity, therefore, a study of motor lubrication requires a knowledge of bearings.

In the plain or sleeve type bearing, study of lubricant characteristics, composition of bearing metals and methods of lubrication is essential to effective bearing protection. This is assured by positive lubrication through continuous delivery of the necessary amount of lubricant to furnish an adequate film, and suitable bearing construction to permit of complete circulation of the lubricant throughout the clearance space which exists between the stationary and moving parts.

Investigations into the theory of lubrication have proved that a definite relation exists between load, operating speed, bearing clearance, viscosity of the lubricant and point of oil application. When lubrication is effective and an adequate film is constantly maintained the bearing serves chiefly as a guide to insure alignment; in event of failure of the lubricating film, however, it devolves upon the bearing to function as a safeguard to prevent actual damage to shafting or other parts of the machine. For this reason sleeve-type bearing metal must be softer than any of the steels used for shafting or journal construction, and capable of wiping or even melting when in actual rubbing contact with the latter, to insure against scoring or cutting. It must be of sufficient hardness to carry the prevailing loads even at abnormally high temperatures, without wiping or becoming distorted, and yet the metal must be sufficiently plastic or ductile to conform to any irregularities on the surface of the shaft.

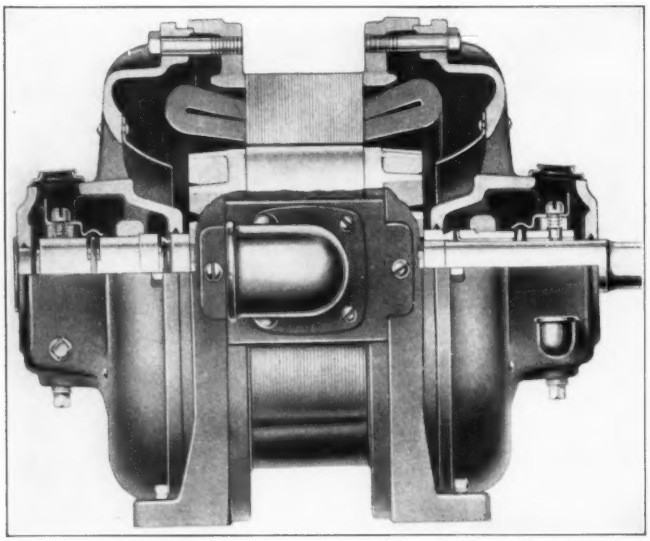
SERVICE APPLICATION

The high speed type of housed or enclosed motor is adaptable to machine tools, textile equipment, shoe machinery, airplane beacon drives, and vacuum cleaning machinery, etc. The sealed housing type of motor, in turn, has found an extensive field of application in dairy, meat packing, grain elevator, cement mill, brewery, stone cutting, and laundry service, etc.

High speed increases windage and the possibility of abrasive materials being drawn through both the bearings and ventilating apertures. High shaft speeds also place a severe load upon the lubricant in its protection of the bearings if high temperatures may prevail. As temperatures increase, it is obvious that the lubricant used must be more resistant to breakdown and formation of gummy, resinous or carbonaceous deposits. In the sleeve type bearing these would tend to accumulate in the oil grooves to interfere with proper circulation of the lubricant. In a ball or roller bearing they would gather in the raceways or cages to impose a braking action upon free rotation of the rolling elements.

More recently, with the introduction of the geared motor, it has also been necessary to consider the possible effect of windage and

dust contamination upon the gear lubricant. The geared motor is an especially valuable means of combining the driving and speed reducing elements in one compact housing which is effectively designed to withstand entry of contaminating foreign matter. It is advantageous where economy of space is essential, and where installation must be made in hazardous or cramped localities.



Courtesy of General Electric Company

Fig. 1—The General Electric squirrel-cage induction motor of the sleeve bearing, ring oiled type. Note sealing, oil level control, and drain plugs.

Planning the Installation

There is an economical advantage to a bearing which is planned so as to be adaptable to standard motor design; it lends to flexibility of installation and low-cost maintenance. Where a sealed type of bearing may be necessary, if it can be installed with but little trouble, it should react to the marked benefit of all concerned. Any movement to facilitate such a procedure will always be appreciated by the lubrication engineer, for he is immediately assured of better performance of his lubricants, and relieved of the possibility of explaining failures which so often are not due to faulty lubrication.

Interchangeability of either sleeve-type or anti-friction bearings can be more readily assured by providing for this procedure when the motor is designed, although it is perfectly feasible to make changes later, especially when new bearings are being considered. In any event, it is important to remember that certain types of bearing seals may require increase in length of the housing. This may in part offset one of the advantages claimed, particularly for the ball bearing, that over-all length is reduced and yet, protection of bearing elements against undue wear by more positive lubrication should be of far more importance.

In the sleeve type bearing provided for oil lubrication by means of ring oilers, a sealed vapor and spray chamber at each end of the bearing, will function to retain oil vapor and spray which may be thrown off by the oil rings. Due provision to return this oil to the reservoir in the base of the bearing is of particular advantage in maintaining economy and cleanliness.

Any lubricant present elsewhere than in the lubricating system may very easily develop a hazardous or sloppy condition which frequently is more detrimental than beneficial. The answer is, therefore, more attention to bearing design and adoption of sealing devices which will positively keep the lubricant where it belongs, and prevent entry of foreign matter.

The Fractional Horse-power Motor

The high-speed fractional horse-power motor is widely planned to employ ball bearings. With some of these units a unique problem is involved in that initial lubrication must be so positive as to warrant no renewal of lubricant for months or even years. The ideal of the motor builder is to obtain a design and a type of lubricant which will function over the life of the machine. Research has made much progress towards this objective; as yet, however, no type of bearing or grade of lubricant has been developed which can be assumed to be entirely free from potential trouble if relubrication is absolutely neglected.

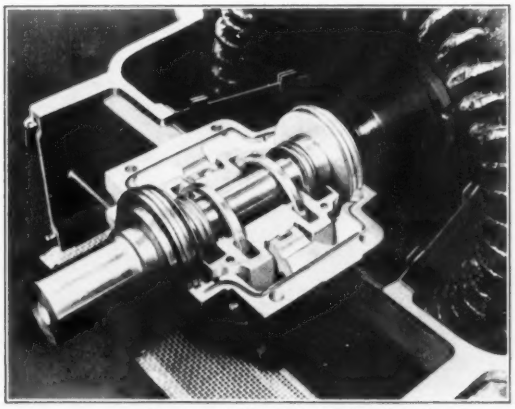
The Petroleum Industry Cooperates

The petroleum industry is particularly interested in this trend of design toward relieving the operators of all thought of lubrication. It is quite reasonable to expect that methods of refinement and compounding will develop greases so strongly resistant to oxidation, separation, solubility or acid or alkali development as to render them quite dependable. It is a field for the grease chemist, but it requires the absolute cooperation of bearing manufacturers, electric motor builders, and bearing engineers. The latter must tolerate moderate advancement, and be prepared to compromise with the grease chemist as research proceeds. Only in this way can best results be accomplished. Any unreasonable attitude toward

methods of test, specification of materials, or the imposing of virtually impossible operating or test conditions will only delay progress.

SLEEVE BEARINGS

The sleeve type motor bearing is conventional in that it is usually composed of babbitt



Courtesy of Allis Chalmers Manufacturing Company

Fig. 2—Top view of the ring oiled sleeve bearing of an Allis Chalmers 3600 r.p.m. squirrel cage motor. Sealing is by means of leatheroid washers backed by metal plates.

or some one of the accepted bronze or white metals which are considerably softer than the mild steel of the rotor shaft. This reduces the possibility of wear of the shaft, yet does not promote wear of the softer bearing metal, provided there is adequate lubrication. Two-part or split bearings are widely used in heavy duty types of industrial motors; with this type of bearing the armature can be readily removed without disturbing the bearing assembly, or the bearing can be removed without displacing the armature. Lower horsepower or fractional motors which employ sleeve type bearings, however, are usually equipped with one-piece shells suitably babbitted.

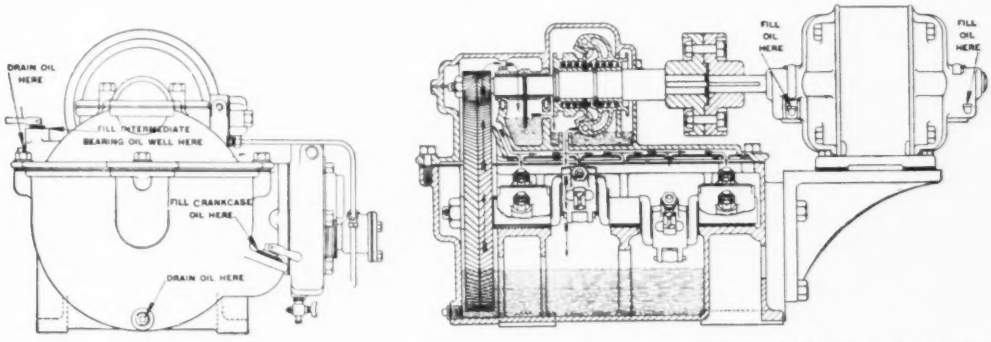
Sleeve-type bearings should be designed so as to provide adequate circulation of the lubricant. In motor service this latter is usually a straight mineral, highly refined oil, of viscosity or body suited to the operating conditions. Normally a range of from 150 to 500 seconds Saybolt Universal at 100 degrees Fahr., will function effectually in the ring or chain oiler, or wick feed system, although petroleum oils of considerably lower viscosity are being considered for some types of specialty motors.

Electric motor builders provide for this by judicious location of bearing oil grooves, and careful cutting away of the bearing metal. In this way the oil is directed to the high pressure area; also the necessary pumping action is developed when the rotor shaft is turning. The oil ring or chain, or the wick element delivers oil to the top of the rotor, but cannot circulate a film through the bearing clearance; wedge action, plus pumping, via the oil grooves completes the cycle.

Oil Groove Design

Oil grooves cut in the low pressure surfaces of the bearing also aid materially in maintaining a sufficiently protective film at the high pressure area, providing the means of initial delivery of oil are adapted to the constructional and operating conditions.

If they are connected or so located with respect to each other and the point of maximum bearing pressure, they provide for not only complete and ready distribution of lubricant throughout the bearing clearance space, but also for collection and subsequent flushing out of any abrasive or other foreign matter which might gain entry to impair lubrication and cause increased friction and power consumption.

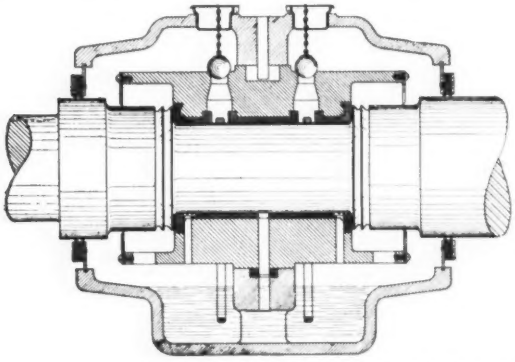


Courtesy of Westinghouse Air Brake Company

Fig. 3—Details of the Westinghouse Air Brake "NWB" motor-driven compressor, showing oil filler fittings and oil drains. Arrows indicate circulation of oil.

With an understanding of the benefits to be derived from grooving of bearings, discussion of how oil grooves function in service will be of interest. Normally, they provide an initial

receptacle for the receiving of lubricant as it passes into the bearing from the lubricator, thus serving as a means for distributing lubrication length-wise along the bearing, so that as the moving surface of the rotating or sliding



Courtesy of Allis-Chalmers Manufacturing Company

Fig. 4—Sectional view of a typical Allis-Chalmers straight seated sleeve bearing for bracket bearing motors. Note oil level and extent of ring immersion.

element passes the grooves or chamfers it will take up an adequate protective film of lubricant.

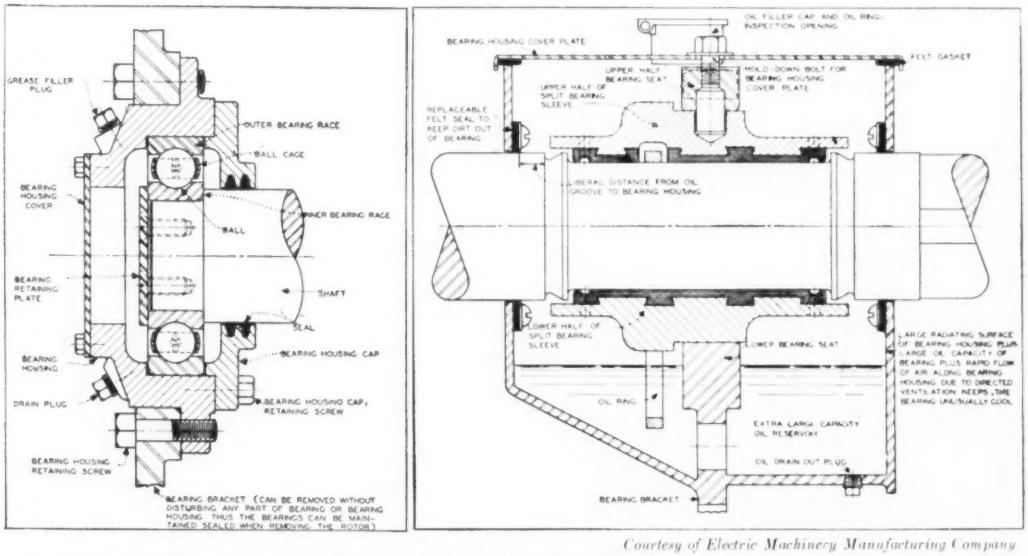
Where properly designed, grooves also aid in retaining lubricant within the bearing clearance space and prevent abnormal leakage via the bearing ends. By suitably designing a system of grooving provision can be made for circulation of oil alternately from the center of the bearing to the outer ends and back again. How intricate such a layout would have to be would depend primarily upon the means of initial lubrication. Where sight feed or drip lubrication is involved, or in other words periodic lubrication with just about the right amount of oil to maintain an adequate lubricating film, grooving will play a more important part than where flood lubrication is employed.

Features in Design

Grooving should be confined to those parts of the bearing which carry the least load. In a two-part bearing this will mean that only the top bearing normally should be grooved. In a four-part bearing, the segments to consider would depend upon the direction of rotation of the journal or shaft. Normally the bottom part should be plain or ungrooved.

No sleeve bearing should be cut-away or have the continuity of its surface altered by grooves within fifteen degrees either way of the point of maximum pressure; otherwise uniformity in the oil film may be impaired. By this same premise the lubricant should wherever possible be led into the bearing at the point where pressure is lowest and where wedge action via chamfering can be employed to aid in film formation.

In other words, theory has proved that the oil must flow from a low pressure area to a zone of higher pressure. Should this latter be grooved to any extent there may be the possibility of oil being carried from the bearing, the lubricating film impaired, waste increased, and the development of abnormal wear. Oil leakage at the bearing ends with increase in temperature can often be regarded as indication of faulty grooving adjacent to the high pressure area.


GREASE FILLER PLUG
OUTER BEARING RACE
BALL CAGE
BEARING HOUSING COVER
INNER BEARING RACE
BALL
BEARING RETAINING PLATE
SHAFT
SEAL
BEARING HOUSING
BEARING HOUSING CAP
DRAIN PLUG
BEARING HOUSING CAP RETAINING SCREW
BEARING HOUSING RETAINING SCREW
BEARING BRACKET (CAN BE REMOVED WITHOUT DISTURBING ANY PART OF BEARING OR BEARING HOUSING THUS THE BEARINGS CAN BE MAINTAINED SEALED WHEN REMOVING THE ROTOR)
OIL FILLER CAP AND OIL RING INSPECTION OPENING
BEARING HOUSING COVER PLATE
FELT GASKET
UPPER HALF BEARING SEAT
HOLD-DOWN BOLT FOR BEARING HOUSING COVER PLATE
UPPER HALF OF SPLIT BEARING SLEEVE
REPLACEABLE FELT SEAL TO KEEP DIRT OUT OF BEARING
RADIAL DISTANCE FROM OIL GROOVE TO BEARING HOUSING
LOWER HALF OF SPLIT BEARING SLEEVE
LOWER BEARING SEAT
LARGE RADIATING SURFACE OF BEARING HOUSING PLUS LARGE OIL CAPACITY OF BEARING PLUS RAPID FLOW OF AIR ALONG BEARING HOUSING DUE TO DIRECTED VENTILATION KEEPS THE BEARING UNUSUALLY COOL
OIL RING
EXTRA LARGE CAPACITY OIL RESERVOIR
OIL DRAIN OUT PLUG
BEARING BRACKET

Courtesy of Electric Machinery Manufacturing Company

Fig. 5—Showing details of bearings for EM motors, at the left being their ball bearing type; at the right, a typical ring oiler. Bearing details with seals are clearly shown.

Where flood lubrication is involved, the arrangement of oil grooving in a bearing will not be so important, nor so contingent upon the direction of rotation as where periodic or drip lubrication is employed. On the other hand, this should not be regarded as a reason for grooving a bottom bearing in, let us say, a ring or pressure oiled system, however, for lubrication would normally not be improved, and the effective bearing area in the high pressure zone would only be reduced. Direction of rotation must always be considered more carefully in a drip lubricated bearing, for flow of oil through the oil grooves may be materially affected. Oil flow should be directed toward the center of the bearing, not toward the ends.

Bearing authorities are in agreement to the effect that oil grooves should never be extended too close to the ends of the bearing surfaces, for in such event oil will tend to escape from the clearance space to be lost by drip or leakage. As a general rule it will be well to keep such grooves a certain distance in from the bearing ends, according to the size of the bearing and journal involved.

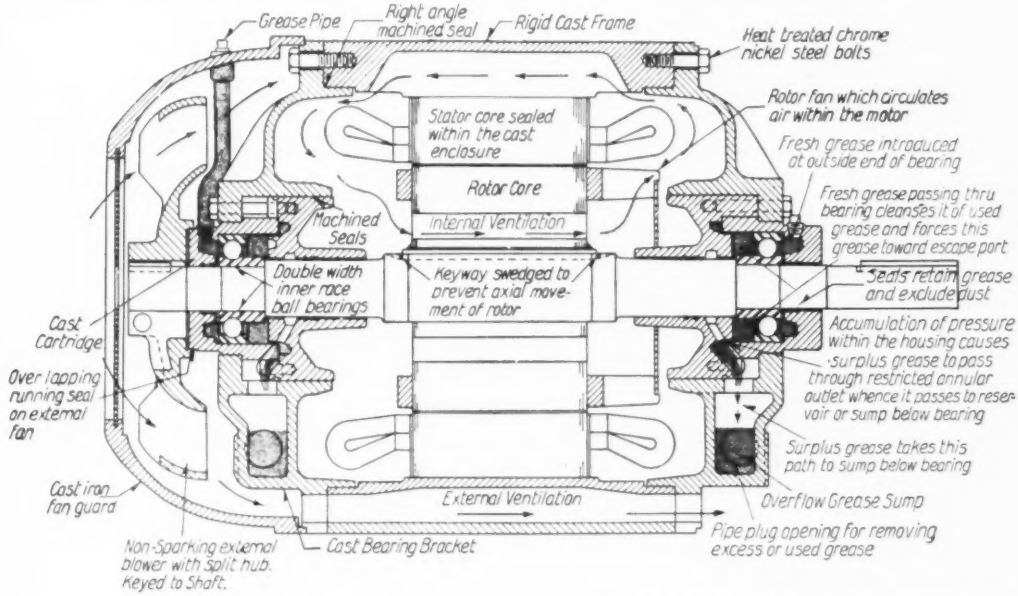
The following table will be of interest in this regard:

Bearing Bore	*Distance of grooves from either end*
$1\frac{3}{4}''$ or less	$\frac{1}{4}''$ max.
$1\frac{3}{4}''$–$2''$	$\frac{3}{8}''$ max.
$2''$–$6''$	$\frac{1}{2}''$ max.
Above $6''$	$1''$ max.

Lubrication Procedure

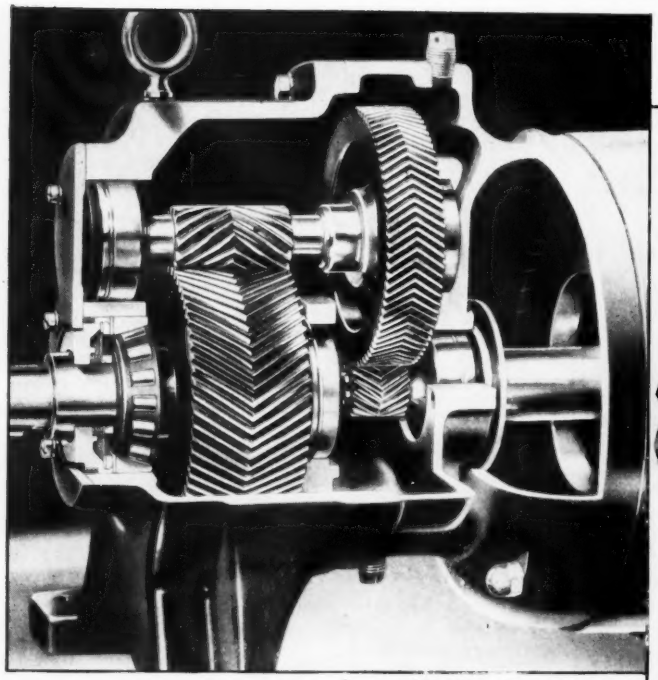
In planning on the lubrication of a sleeve-type motor bearing, it is important to realize that the limited quantity of oil involved and the rapid rate of circulation in motor service requires careful consideration of both the quality and the probable operating viscosity. As this latter is influenced by temperature, the operating range should be ascertained and the viscosity of the lubricating oil decided upon accordingly. There is but little opportunity for extensive cooling other than by radiation of heat from the exterior of the bearing or its oil reservoir. Yet, experience has indicated that even this comparatively small area will suffice to keep the bearing temperature well below the danger point, and usually comfortable to touch. Normally, too, the oil reservoir in the modern motor ring-oiled bearing will be of adequate capacity to give the oil some time to rest and settle out any sediment or foreign matter that may have been picked up through windage or penetration. The lighter the oil the more readily will this occur.

It is important to remember that settling and radiation become more effective provided the oil level is not carried too high. Renewal of lubrication is also important. Provided there is an oil filler and gauge installed (to control the oil level) it will be more cleanly and economical to add oil at this point while the motor is idle, to about one-eighth of an inch from the top, instead of filling through the


Grease Pipe
Right angle machined Seal
Rigid Cast Frame
Heat treated chrome nickel steel bolts
Rotor fan which circulates air within the motor
Stator core sealed within the cast enclosure
Fresh grease introduced at outside end of bearing
Rotor Core
Fresh grease passing thru bearing cleanses it of used grease and forces this grease toward escape port
Machined Seals
Internal Ventilation
Seals retain grease and exclude dust
Double width inner race ball bearings
Keyway swedged to prevent axial movement of rotor
Cast Cartridge
Accumulation of pressure within the housing causes surplus grease to pass through restricted annular outlet whence it passes to reservoir or sump below bearing
Over lapping running seal on external fan
Surplus grease takes this path to sump below bearing
Cast iron fan guard
External Ventilation
Overflow Grease Sump
Non-Sparking external blower with Split hub. Keyed to Shaft.
Cast Bearing Bracket
Pipe plug opening for removing excess or used grease

Courtesy of Westinghouse Electric & Manufacturing Company

Fig. 6—Section of the Westinghouse dual-ventilated, explosion-proof, fan-cooled motor. Note points of grease application, the shaded portions adjacent to the bearings indicating path followed by grease to and through the self-cleaning bearings.

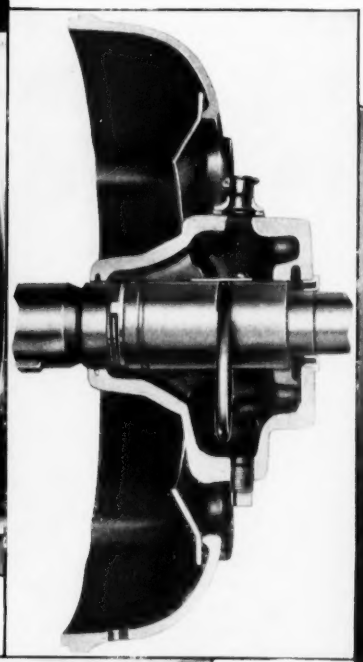


Courtesy of The Master Electric Company

Fig. A (Above)—Gear and bearing end of a Master gearhead motor showing method of sealing the housings to prevent leakage of oil or dust contamination.

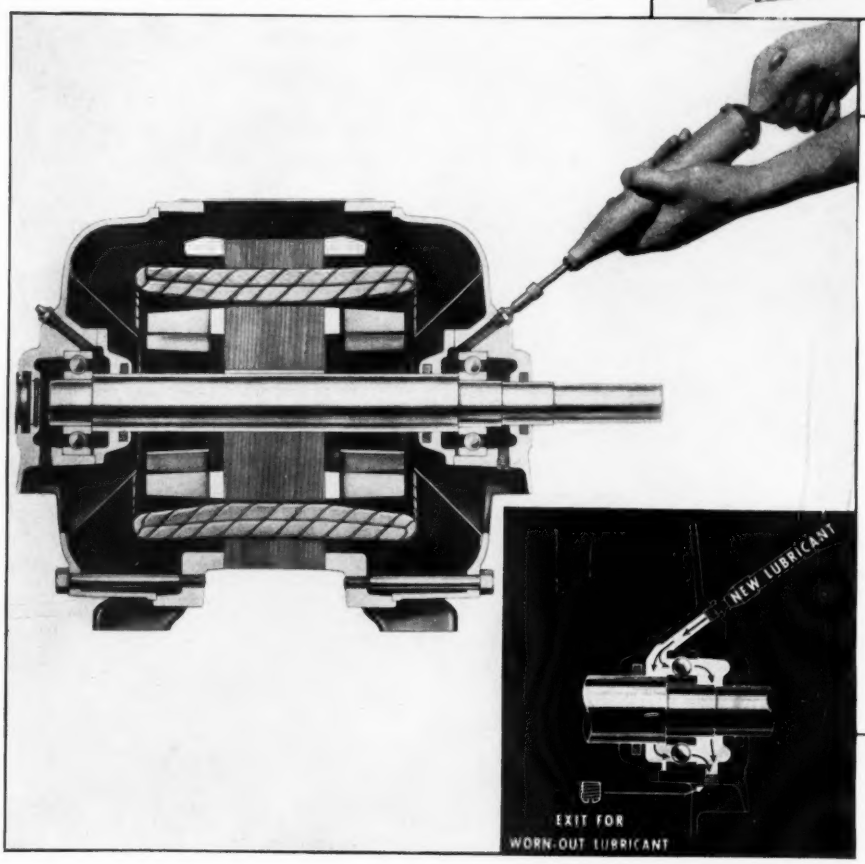
Courtesy of Century Electric Company

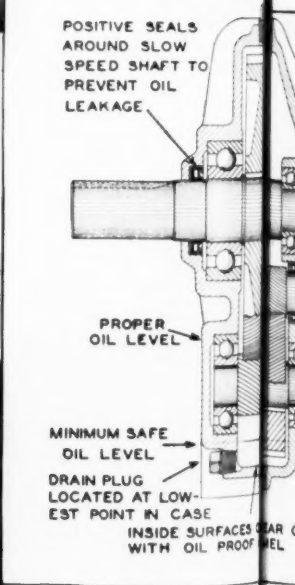
Fig. B—Cross-section of a Century ring-oiled sleeve bearing. Note oil filler and drain plugs, the end play bumpers, and method of sealing.



Courtesy of

Fig. C—A
assembly sh
oil level belo
possibility of



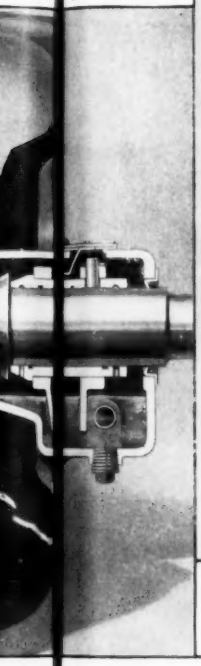


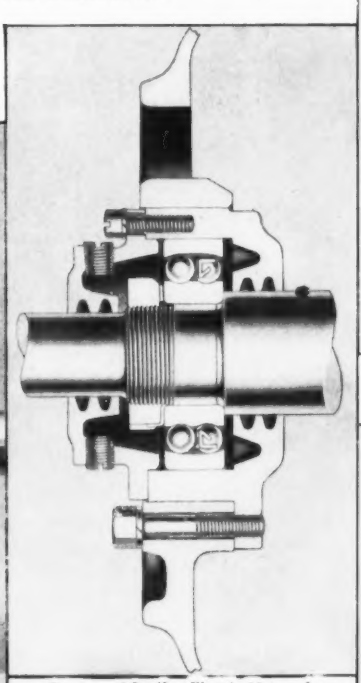
Courtesy of U. S.

Fig. F (Left)—The U. S.
ball bearing lubrication. Here
fresh grease through the bearing
lubrication forces all old grease
fice. Obviously, the plug must be
pose. No dead pockets of grease

Courtesy of Fairbanks, Morse & Company

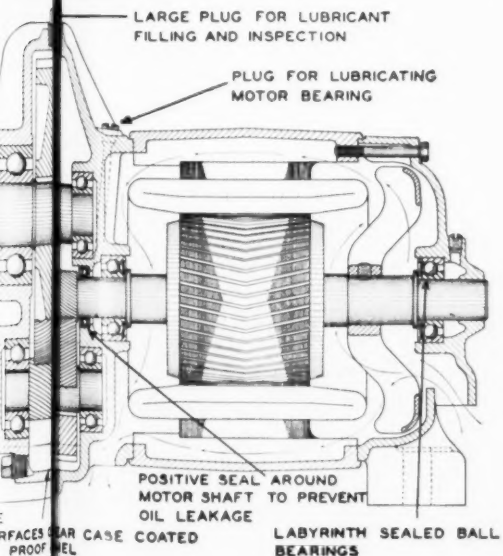
Fig. D—A F-M self-aligning double row sealed ball bearing in cartridge type mounting which excludes all dirt.





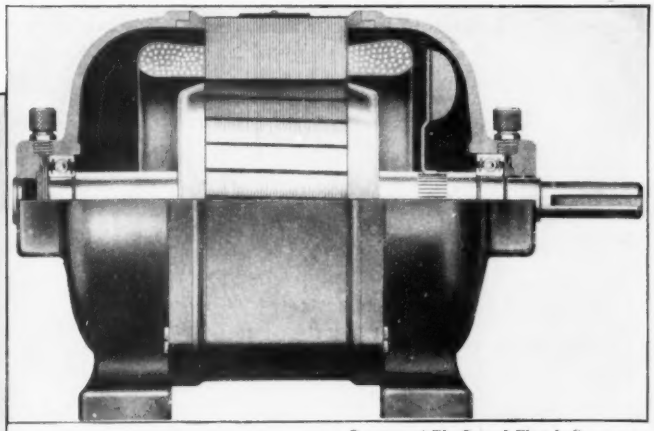
Courtesy of Sterling Electric Motors, Inc.

Fig. G (Below)—Section of a Sterling Slo-Speed motor showing bearing and gear arrangement, also methods of bearing sealing.


LARGE PLUG FOR LUBRICANT FILLING AND INSPECTION
PLUG FOR LUBRICATING MOTOR BEARING
POSITIVE SEAL AROUND MOTOR SHAFT TO PREVENT OIL LEAKAGE
LABYRINTH SEALED BALL BEARINGS

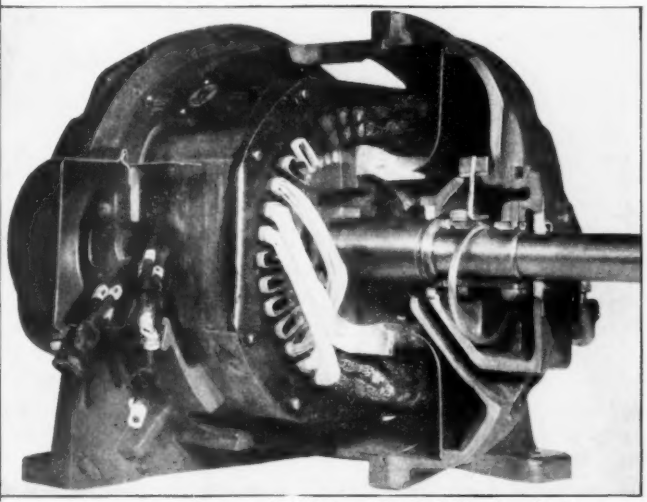
Courtesy of General Electric Company

Fig. K (Right)—Details of a General Electric squirrel cage induction motor showing ball bearing assemblies. Note pressure grease fittings, relief plugs, and method of sealing.



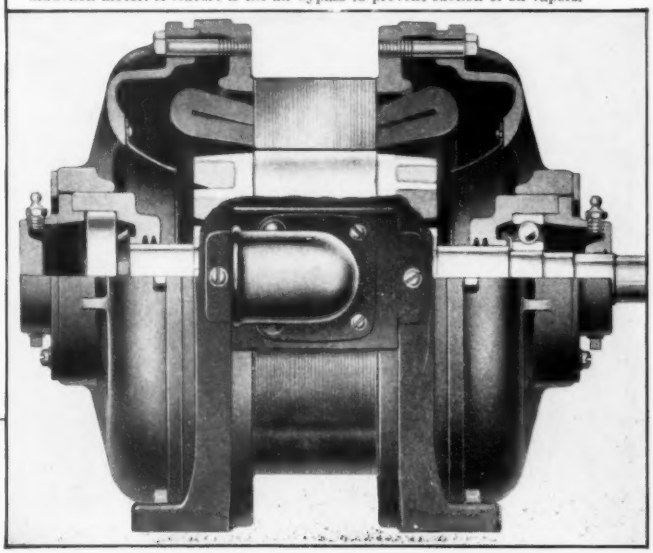
Courtesy of The Leland Electric Company

Fig. E (Above)—Cutaway of a Leland polyphase motor; note ball bearing and seal arrangement, also provision for relubrication.



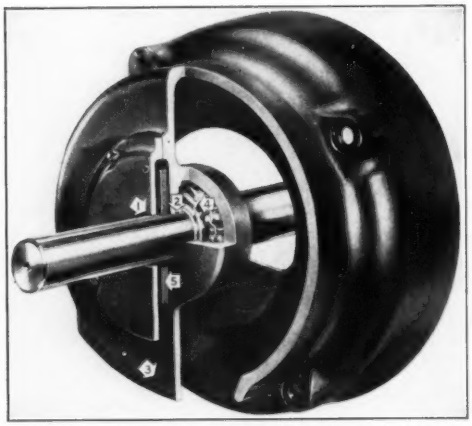
Courtesy of Westinghouse Electric & Manufacturing Company

Fig. H (Above)—Showing details of the Westinghouse ring oiled squirrel cage induction motor. A feature is the air bypass to prevent suction of oil vapors.



inspection port at the top. The latter procedure often leads to waste through over-flow.

Another important factor to consider is the matter of oil finding its way into the motor. This may be due either to windage along with



Courtesy of The Master Electric Company

Fig. 7—End view (cutaway) of a Master splash-proof motor bearing, showing at (1), the bearing guard; at (2), the labyrinth grease seal; at (3), the extra long skirt to prevent entry of water; at (4), the lubri-seal ball bearing; and at (5), the slinger which also prevents entry of water along the shaft.

the development of oil spray where the oil level is carried too high, or to the fact that the oil overflow is not large enough.

It is apparent that oil which is carried to the top of a ring-oiled bearing must be taken care of and returned to the reservoir as rapidly as it is delivered by the ring. If this is not possible, oil will tend to accumulate in the upper part of the housing to ultimately be forced into the interior of the motor. This, of course, is detrimental to the coils. In fact, authorities contend that in the steel industry, for example, oil-soaked insulation is one of the most prevalent motor troubles, the cost of repairs being proportionately high.

The same condition may arise if the oil is carried too high in the well, or if the ring rotates at too high a speed. This will cause a splashing and churning of the oil, with the result that wherever there is any windage or draft through the bearing and motor, the oil spray may be carried in.

To preclude the possibility of such occurrences and as well, to protect the armature coils and pole windings, motor builders install oil baffles, throwers or labyrinth packing on the motor or inboard side of the bearing and oil filler plugs on the side of the housing. Such devices in particular prevent direct circulation of air from the outside and through the bearing. In company with proper grooving of the bearing metal to permit ready distribution and return of the oil, they are regarded as adequate assurance that the latter will function as intended and not find its way within the motor.

To best effect lubrication by means of ring oilers, under normal temperature conditions it is generally essential to use a high grade straight mineral oil of approximately 180 to 200 sec. Saybolt at 100 degrees Fahr. By virtue of the fact that electric motors may frequently be called upon to function under abnormally low temperatures, an oil with a low pour test should be chosen wherever possible. If this latter approximates zero degrees Fahr., it will generally function satisfactorily. On the other hand, higher temperatures will oftentimes require additional viscosity to resist the thinning down action of heat. Under such conditions, an oil of from 300 to 500 sec. viscosity or even higher may be advisable.

BALL AND ROLLER BEARINGS

The application of the ball and roller bearing to electric motor service was a logical step in the perfection of the enclosed-type industrial motor, likewise the smaller horsepower household unit. This, in turn, imposed an added responsibility upon the bearing manufacturers, as it required improvement of bearing seals, not only to extend the life of the quality lubricants which were necessary for lubrication, but also the prevention of entry of contaminating foreign matter. Effective sealing also reduced windage. Low power consumption likewise became a factor in the development of bearings for the fractional horsepower motor, as this was proved to be a function of lubrication. Grease research was concentrated upon the study of ball and roller bearing greases of low torque characteristics, likewise maximum stability.

The duty of the lubricant in a ball or roller bearing is extended beyond actual lubrication. The ability to prevent actual metallic friction must be supplemented by the protective ability, whereby the lubrication film is such that corrosion is prevented, even under a wide variation in atmospheric conditions.

Rolling motion is essentially involved, meaning that in a properly designed bearing which has not been subjected to abnormal wear, the possibility of sliding contact will be relatively negligible. Actual contact between metallic bearing surfaces of the balls or rollers and their cages or retainers is the principal cause of wear due to development of metallic or solid friction. To prevent this, a lubricating film is interposed; that is, a film of suitable thickness and body to keep the metallic surfaces apart in the face of the prevailing speed and pressure. In this way fluid friction supplants solid friction to reduce the ultimate wear.

It is, of course, desirable to reduce frictional

wear in any electric motor bearing as much as possible. The occurrence of undue wear may lead to misalignment which, in turn, may cause the rotor shaft to pound in its bearings and the armature coils to come in contact with the pole pieces which may result in burnouts. Not only will these be costly from a repair point of view, but also they will slow up production or whatever process of manufacture with which the motor in question may be connected.

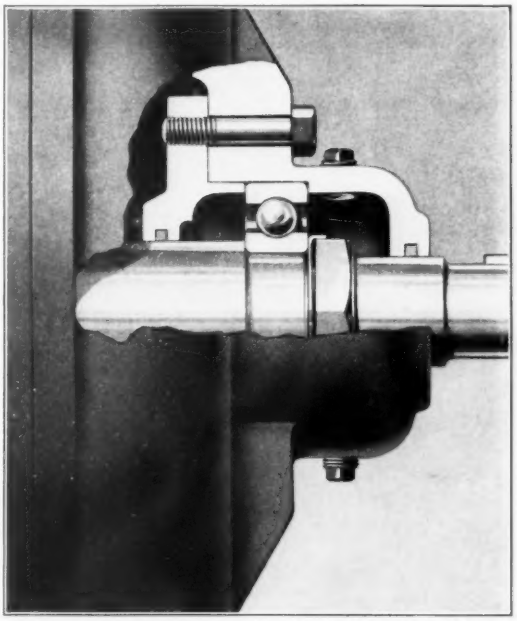
The sealed-type of prelubricated ball bearing is being widely used in small motor service today where precise control and low power consumption are of chief importance. This includes household equipment, such as electric refrigerators, vacuum cleaners, and heating appliances; also small high speed machine tools and even some types of textile machinery. The effect of the choice of lubricant on speed is an important factor where speed must be accurately controlled in precision equipment, especially in metal grinding, stone cutting, and textile knitting. Power consumption enters into production costs.

METHODS OF SEALING

The type of seal to be applied to an electric motor bearing, will of course depend upon the bearing itself. In any event, the purpose of the seal is to prevent leakage of lubricant or entry of contaminating foreign matter. The ring oiled sleeve bearing can be designed for this by providing adequate return grooves or passages at each end of the bearing in order to return the oil to the reservoir in the base; at the same time this return oil will flush out any non-lubricating material before windage can draw it through the bearing.

The ball or roller bearing being lubricated most generally by grease, and devoid of lubricant circulation beyond the bearing, must be sealed as a unit.

A variety of seals have been developed including felt and cork washers or gaskets, metallic slingers, dust collars, expanding leather devices, grease-filled grooves, or various combinations of these. Proper sealing not only protects the bearing but also insures against premature failure of lubrication. In motor design the trend is more and more to build a unit which will be immune to external conditions. The modern splash proof motor is typical of this activity. Here, not only the bearings but also the windings are insured against entry of any type of foreign matter. Any leakage of lubricant in such a unit would obviously be to the detriment of not only the bearings but also the adjacent motor parts. In this development high temperatures also had to be considered, especially for motors designed for steel mill, stoker, and economizer service. The effect of high temperature on certain sealing materials involves deterioration. The effect of high temperature on lubrication is to reduce the viscosity or consistency of any lubricant. The extent to which this will occur depends, of course, upon the original



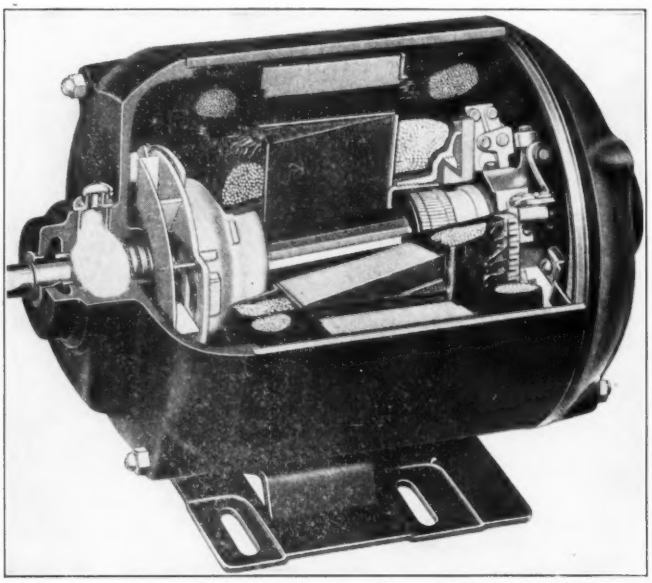
Courtesy of The Louis Allis Company

Fig. 8—A Louis Allis ball bearing assembly. Note large grease chamber and felt seals to exclude dust and dirt.

body of the product. Unless the latter is of the nature of steam cylinder oil and possessed of adequate viscosity, at steel mill temperatures considerable leakage may result from certain types of bearings. For this reason, steam cylinder stocks are used in certain grades of high temperature ball and roller bearing greases. With a lubricant of this nature, plus a suitable bearing seal, leakage, even under extreme temperatures, can be prevented to a marked degree.

When bearing sealing was first considered, felt and leather washer and grease-groove seals were preferred due to low cost and simplicity of design. These advantages still hold. Since their development, however, other types of seals have come into usage including metallic rings similar to piston rings, mercury baths in connection with vertical installations, and metallic springs for the purpose of maintaining the adjustment of felt, leather, rawhide, and cork with respect to the rotating element. Composition rings have also proved of value as oil seals, or to protect a grease-lubricated

bearing against entry of water. At high speeds however, the power loss factor due to actual contact of the seal may become quite material.



Courtesy of Century Electric Company

Fig. 9—Cutaway of a Century fractional horsepower motor showing provision for oil lubrication via long fibre wool yarn. This latter serves only filtered oil to the bearings.

This is why grease-groove seals are preferred by some builders. Vertical motor installations have called for considerable study of sealing devices. The ball bearing has proved to be particularly adaptable to such motors, due to its dependability under high speeds and intensive thrust loads.

Wear Must be Low

The most effective bearing seal must not only seal, but also show practically no wear in service; otherwise, the purpose may be more or less defeated. Washer type seals may consequently be unsatisfactory, although the rate of wear will depend upon the quality of the material. This is why adjusting springs are used today in connection with washer or leather cup seals in order to keep the material in close contact with the shaft or journal surface, and thereby compensate for wear and enable dependable retention of lubricant.

Grease groove seals are used to prevent leakage of lighter lubricants. They are also relatively simple and inexpensive to design. They must be periodically examined, however, in case the sealing grease requires renewal. Otherwise, possible glazing of the surface of this latter where it comes in contact with the rotating shaft might result in sufficient clearance to allow leakage of the bearing lubricant. Very heavy bodied greases of high melting point are adaptable to service as grease seals, provided they show no tendency to separate oil from soap, and contain no material which might be abrasive to the shaft surface. Grease grooves can also be used together with felt washers in certain types of service, although this may require extension of the length of the bearing housing.

Many authorities, however, feel that the spring adjusted seal insures the most uniform contact and conformation with the surface of the rotor shaft. It is extensively applied to fabric or cup leather seals when most positive sealing is essential and where first cost should be of secondary consideration. This type of seal is well suited to the ball or roller bearing, where use of a minimum amount of housing space is advantageous. It is preferred by many where moisture, abrasive dust or metallic particles must be kept out of the bearings.

CLEANING AND FLUSHING

Motor bearing lubrication is further protected if there is suitable provision for complete cleaning or flushing when necessary. The frequency of such a procedure will be governed by the type of bearing and the conditions to which it is exposed. Ring chain and collar oilers automatically flush themselves to settle any foreign matter in the reservoir below the bearing. Wick oilers or other methods of periodic lubrication are not so effective; here, if foreign matter can get in, it stays there until the bearing assembly is flushed and cleaned. The same holds true for the grease-lubricated ball or roller bearing.

Sealing to prevent entry of such foreign matter automatically protects both the bearing and its charge of lubricant. It is especially important to protect the ball or roller bearing, as churning of abrasive foreign matter with grease between moving parts which are precision-built to clearances of only a few ten-thousands of an inch will cause serious damage to the bearing elements. For this reason, specialty greases for ball and roller bearings are prepared from carefully selected and filtered ingredients, and even later filtered by some ball bearing manufacturers, if they are to be used in pre-lubricated sealed-type precision bearings. In service, afterwards, the seal should be so effective as to keep such lubricants in this high state of purity. Given a good grease and a good bearing seal, relubrication is necessary at very infrequent intervals,

some jobs being able to run for several years on the initial charge of grease.

To set any hard and fast rule, even with the best of seals, is unwise, however, due to the wide variety of service to which motors must be subjected, particularly in industrial or power plants. The extent to which dust, dirt, metallic chips or scale may be present in the air or thrown on to any bearing will, of course, be an influencing factor. So suitable provision is usually made for drainage of lubricant and flushing oil by locating an outlet in the base of each bearing which can be tightly plugged in service; this will prevent leakage during operation. Sometimes this can be elaborated upon where oil is employed for lubrication by an arrangement of nipples and pipe fittings terminating in a sight gage glass. This facilitates not only cleaning, but also observation of the oil level in the bearing.

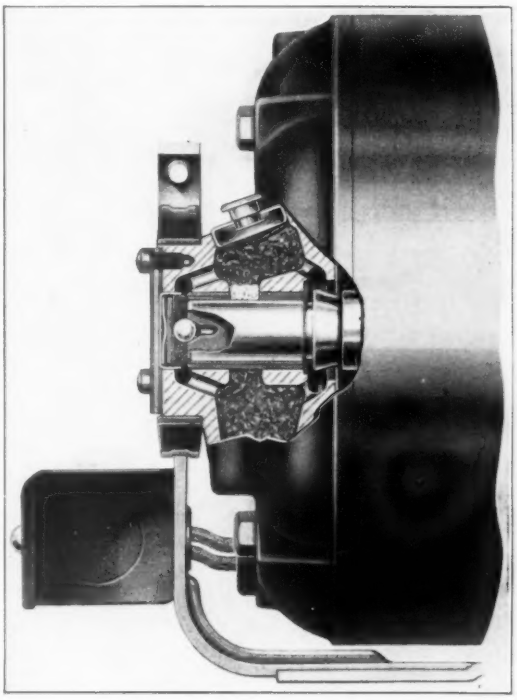
Oil lubricated sleeve-type bearings should be gaged regularly for oil level in the reservoirs, and only the amount of oil necessary to bring the level to the proper height should be added.

In the railway-type motor, should gaging show that very little oil has been fed since the last inspection, there is good reason to believe that the hole at the bottom between the two wells is plugged, and it should be cleaned before oil is added. By keeping this hole open, all oil can be added through the oil well rather than at the top of the waste. Some dust is bound to get into the waste, and adding the oil on top washes the dust down to the bearing. If evidence of water is found in the waste, the latter should be removed and the bearing packed with new waste. Water-soaked waste is less able to hold and deliver oil to the shaft surface.

Location Important

In steel mill, cement plant, grain elevator, and flour mill service, dust and dirt may be especially serious. When such material can penetrate within a bearing assembly, the detrimental results which would develop in the form of scored bearing elements, misalignment, and the necessity for bearing replacement, with the attendant effect upon production, are quite obvious.

As it is not always possible to completely seal a bearing or to depend upon the seal being in proper condition at all times, motor bearings which may be exposed to excessive abrasive or non-lubricating materials should be flushed and cleaned at regular intervals. The frequency, of course, will depend upon the design of the bearing, the type of seal, the extent to which dust, dirt, scale, or water may be present, and the nature of the lubricant. Some classes of steel or paper mill service will be more subject to contamination of lubricants than others. Some types of bearing seals also will be more effective than others. Yet, even with such



Courtesy of The Emerson Electric Manufacturing Company

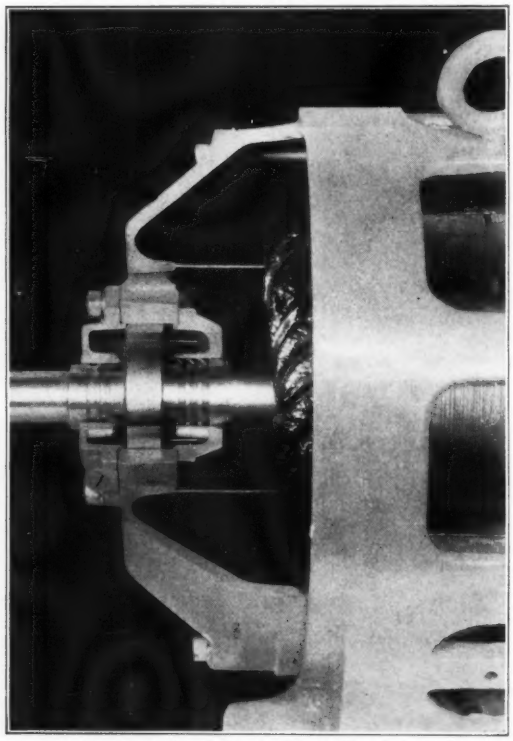
Fig. 10—Details of an Emerson ball thrust bearing in the back end-cover of a motor. This provides quiet, smooth operation. The shaft turns against the ball bearing and a felt washer saturated with oil. The oil reservoirs are packed with wool; cotton wicking leads oil from both upper and lower reservoirs to the shaft and bearing.

precautions, cleaning of the bearings should not be neglected, for experience has proved that their life can be materially lengthened by such attention. Cleaning can be most effectively accomplished by flushing with a light oil which has been heated to around 140 degrees Fahr. Application while the motor is running, with the drain plug removed, will usually remove all soap and foreign matter deposits. Hydro-carbon solvents are not advisable, especially when greases have been used, due to the possibility of non-soluble soap residues remaining within the housing after their oil content has been taken up by the solvent.

Cleaning Procedure

Ring oiling systems will often require more frequent attention than ball or roller bearings, as their housings cannot always be so tightly built. With the former, cleaning may be necessary or advisable at periods ranging from every two weeks to every several months; whereas in normal service a properly sealed ball or roller bearing may function indefinitely.

unless operating conditions are especially dirty. On the other hand, the so-called anti-friction bearing is more delicate from the viewpoint of construction, and, therefore, its lubricant



Courtesy of Crocker-Wheeler Electric Manufacturing Company

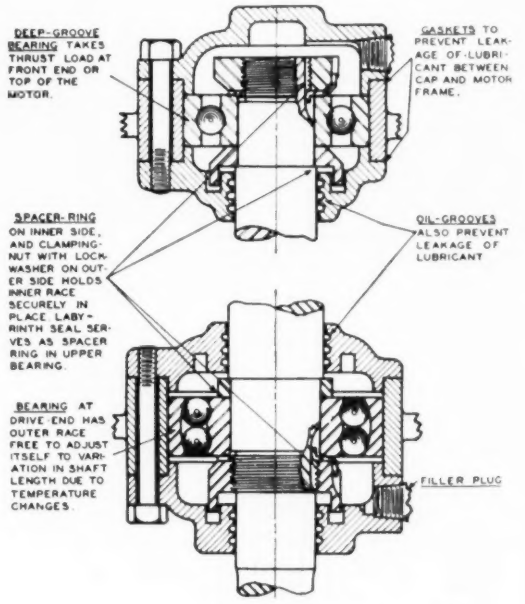
Fig 11—Exposed view of a Crocker-Wheeler anti-friction bearing assembly. This provides against grease leakage by virtue of an air-tight seal which is developed by pumping action. This prevents entry of abrasive foreign matter, and permits the use of a light bodied grease.

should not be allowed to become so contaminated as is permissible in a sleeve-type bearing.

Wherever grease lubricated ball or roller bearings are involved, and drainage cannot be readily carried out, due perhaps to the body or consistency of the lubricant, the grease should be wiped out thoroughly at the period of cleaning. It is also practicable to flush some types of ball and roller bearings with hot oil as explained above. Such bearings can be all the more completely cleared of used grease if the drain plug is removed when new grease is applied.

Ring oiling systems possess natural advantages in that the flood of oil which is constantly passing through the bearings tends to wash out any grit, dirt, dust, or metallic particles that may have gained entry. As a result, wear is reduced to a minimum, just as long as the oil in the system does not become so highly contaminated as to be unable to precipitate such foreign matter during its period of so-called rest. This flooding of bearings, by virtue of its washing action, naturally gives rise to gradual accumulation of foreign matter; therefore, the condition of the oil should be carefully watched, and the system drained when any excess of dirt becomes apparent.

A flushing oil wash (using an automotive type of crankcase flushing oil) will normally take up and remove such material. In an installation which has been subjected to severe service, neglected or filled with an unsuitable gum-forming lubricating oil, a petroleum solvent may be required. The use of comparatively warm flushing material is also helpful. If a chlorinated solvent is used, it should be applied immediately the motor is shut down, adding about ten per cent by volume to the used oil. Running the motor for a few minutes


DEEP-GROOVE BEARING TAKES THRUST LOAD AT FRONT END OR TOP OF THE MOTOR.
GASKETS TO PREVENT LEAKAGE OF LUBRICANT BETWEEN CAP AND MOTOR FRAME.
SPACER-RING ON INNER SIDE, AND CLAMPING-NUT WITH LOCK-WASHER ON OUTER SIDE HOLDS INNER RACE SECURELY IN PLACE. LABYRINTH SEAL SERVES AS SPACER RING IN UPPER BEARING.
OIL-GROOVES ALSO PREVENT LEAKAGE OF LUBRICANT
BEARING AT DRIVE-END HAS OUTER RACE FREE TO ADJUST ITSELF TO VARIATION IN SHAFT LENGTH DUE TO TEMPERATURE CHANGES.
FILLER PLUG

Courtesy of Wagner Electric Corporation

Fig. 12—Bearing assembly for a Wagner vertical end-plate mounted motor. Essential details are plainly indicated.

with immediate draining thereafter will preclude condensation of moisture and possibility of formation of corrosive hydrochloric acid. After such treatment the bearing should be flushed with mineral flushing oil before refilling with new lubricating oil.

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TEXACO

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RING OILERS

Normal Temperatures	TEXACO Cetus Oil TEXACO Canopus Oil or TEXACO Nabob Oil
Low Temperatures	TEXACO Cetus Oil or TEXACO 542 Capella Oil
High Temperatures	TEXACO Alcaid or Algol Oil or TEXACO Aleph or Altair Oil

BALL AND ROLLER BEARINGS

(Oil Lubricated)

Where Housings are oil-tight, operating conditions normal and speeds high	TEXACO 542 Capella Oil TEXACO Alcaid Oil or TEXACO Regal Oil B
For Roller Bearings where end thrust is appreciable; and Ball Bearings under low speeds and higher temperatures	TEXACO Alcaid Oil TEXACO Algol or Ursa Oil or TEXACO Texols
For Roller Bearings operating under extreme temperature and pressure	TEXACO Regal Oils or TEXACO Texol J

BALL AND ROLLER BEARINGS

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According to type and construction of the bearings, operating pressures and temperatures	TEXACO Starfak Grease No. 2 or No. 3 TEXACO Marfaks or TEXACO Star Greases
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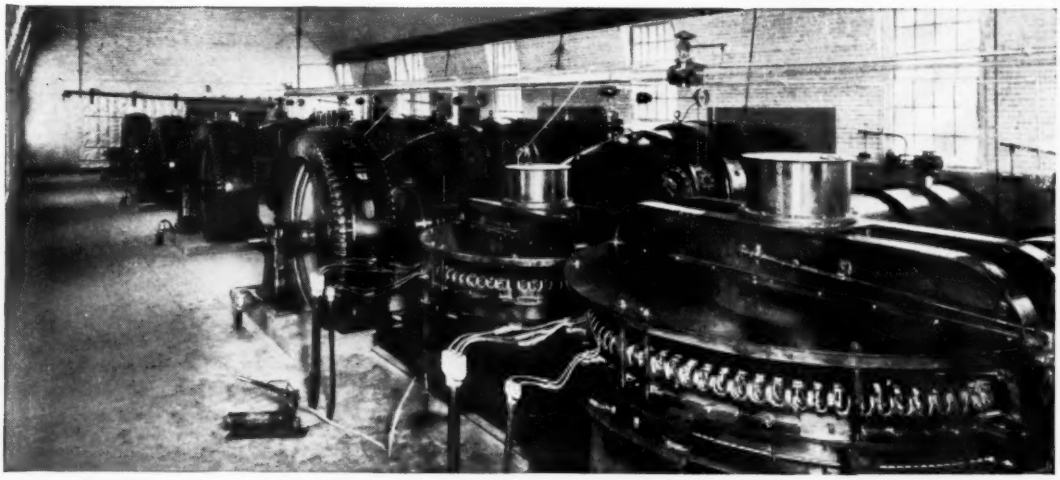
Making a Desert

"Blossom as the Rose"



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